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Emotion and the Autonomic Nervous System: Introduction to the Special Section

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For this special section of *Emotion Review*, the authors were asked to address three issues related to the role that the autonomic nervous system (ANS) plays in emotion: (a) the degree to which different emotions are associated with different patterns of ANS activity; (b) the influence of ANS activity on subjective emotional experience; and (c) how to improve research in this area. The authors of the three articles share a longstanding involvement in research on the ANS and emotion, but represent quite different theoretical traditions and differ in how they study emotion. Thus, not surprisingly, the resulting articles differ markedly in the relative attention they give to each topic and in the ways the topics serve as jumping-off points into larger issues.

In reading the three articles together, I am struck by the longevity and durability that Darwin's (1872) and James' (1884) ideas on the specificity side and Cannon's (1927) and Schachter and Singer's (1962) ideas on the undifferentiated side have had in shaping this debate. This is all the more remarkable when one considers that Darwin, James, and Cannon did not produce significant bodies of empirical research on the role of the ANS in emotion, and many critics have argued that Schachter and Singer's classic study (Schachter & Singer, 1962) is seriously, and perhaps even fatally, flawed. It will be interesting to see if these historical figures continue to cast their spell over the new generation of emotion research, which still honors the important role the ANS plays in emotion, but is arguably much more focused on the brain and on the ways that emotion is regulated and recognized.

In the article by Norman, Berntson, and Cacioppo (2014), the authors take a relatively moderate position as to the level of empirical support for ANS specificity in emotion. They point to the considerable evidence that specificity exists, but note the inconsistencies in the nature of that specificity and its vulnerability to contextual influences. These authors work from a sophisticated model of emotion (the evaluative space model) that is unusual in its ability to accommodate both discrete and dimensional approaches. Whatever one's theoretical predilections, it is clear that humans are quite bilingual when it comes to the ability to think, talk about, and experience their emotions in both dimensional and discrete ways. A theoretical approach that allows the study of both in concert (rather than choosing one and excluding the other, or, even worse, lionizing one and vilifying the other) is critical for exploring the ways dimensions and discrete emotions interact. The authors also offer important theoretical insights about the ways that somatovisceral activity can shape emotional processes. Their somatovisceral afference model describes multiple pathways for this influence at ascending levels of the nervous system and envisions ways that the information from these pathways is represented and integrated.

Lang's (2014) article is markedly less sanguine about the state of empirical support for ANS specificity, at least as it pertains to discrete emotions. Instead, he argues for specificity of a different kind, making a strong case that different patterns of ANS response are associated with two broad motivational states: (a) defensive, coping reactions to external threats, and (b) appetitive reactions to obtain rewards and address needs that are life sustaining. In his model, activation of the brain circuits associated with these motivational states contributes to subjective experience, but again not at the level of discrete emotions. Thus, activation of defensive circuitry evokes unpleasant/aversive subjective states and activation of appetitive circuitry evokes pleasant/desirable subjective states. In his article, Lang provides a detailed description of the brain circuitry involved with these two motivational states and includes their links with ANS control systems in the brainstem, striatum, and other phylogenetically ancient brain regions.

Lang also points to a number of the intrinsic and arguably insoluble problems that plague research on "emotional feelings" (i.e., conscious emotional experience). He suggests that future research on the ANS in emotion would be better served by exploring the links that ANS activity has with particular patterns of brain activity rather than with self-reported evaluations of emotional states. He also makes an interesting connection with recent attempts in the realm of psychopathology and mental illness to define and study emotional disorders in terms of biomarkers and associated neural circuits rather than in terms of the traditional clinical syndromes that are based on subjective symptoms (Cuthbert & Insel, 2013).

Of the three contributors, I am probably the most sanguine about the likelihood that ANS specificity will ultimately be established (at least for a small set of discrete emotions).

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However, having written about related issues recently in this journal (Levenson, 2011), I decided to do something different. Thus, in my article (Levenson, 2014), I consider two different kinds of patterning of ANS response in emotion that are found in most functionalist/evolutionary theories. One of these is ANS specificity, a theme in common with the other two papers. The other, equally important theoretically, is coherence, the capacity of emotion to mobilize and organize activity both within the ANS and between the ANS and other emotion response systems (e.g., facial expression, vocalization, motor behavior). For both coherence and specificity, I go back to first principles, describing the ways that these two kinds of ANS patterning are envisioned in theory and then discuss what research would look like that captures these conditions with the highest possible fidelity. With coherence research, I conclude that almost none of the existing studies have studied coherence in ways that are consistent with the theoretical accounts. Interestingly, among the few studies that have, quite high levels of coherence were found between the ANS and other response systems. With specificity research, there are certainly many excellent studies, but I conclude that the field would be well served by: (a) moving beyond its focus on convenient measures (i.e., heart rate and skin conductance), (b) including measures of ANS activity that have greater signal value for conspecifics (e.g., blushing, crying), (c) studying more intense emotions, (d) using more careful verification of emotional state, and (e) matching ANS physiology more precisely with the occurrence of emotion.

I hope that readers of this special section, both those who are already conducting research on the role of the ANS in emotion and those who will be conducting this kind of research in the future, will find these three articles to be useful, interesting, and thought-provoking. The many controversies and passionate debates that this research area has spawned over the decades serve as an eloquent statement of just how important these scientific questions have been and will continue to be.

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